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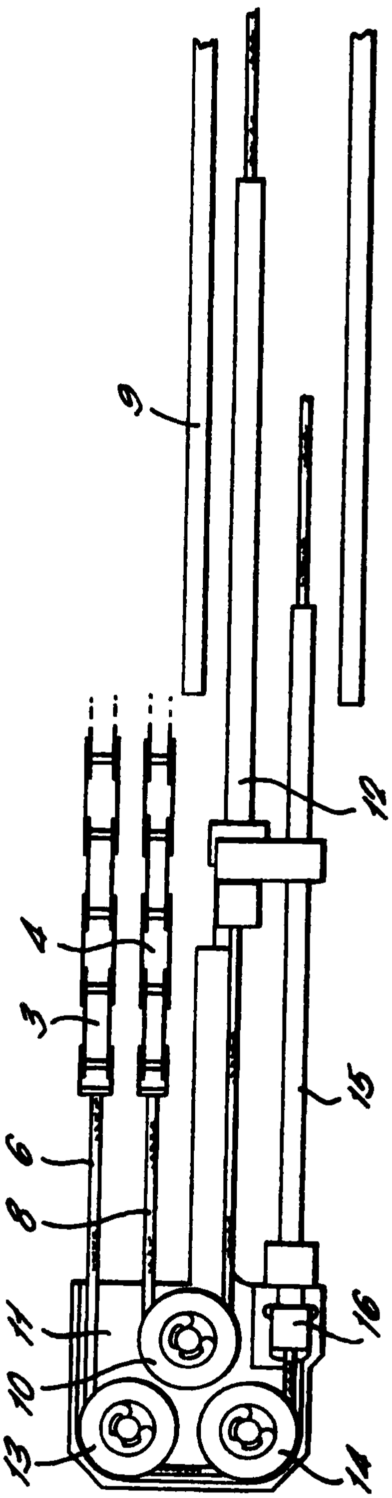


FIG. 1.

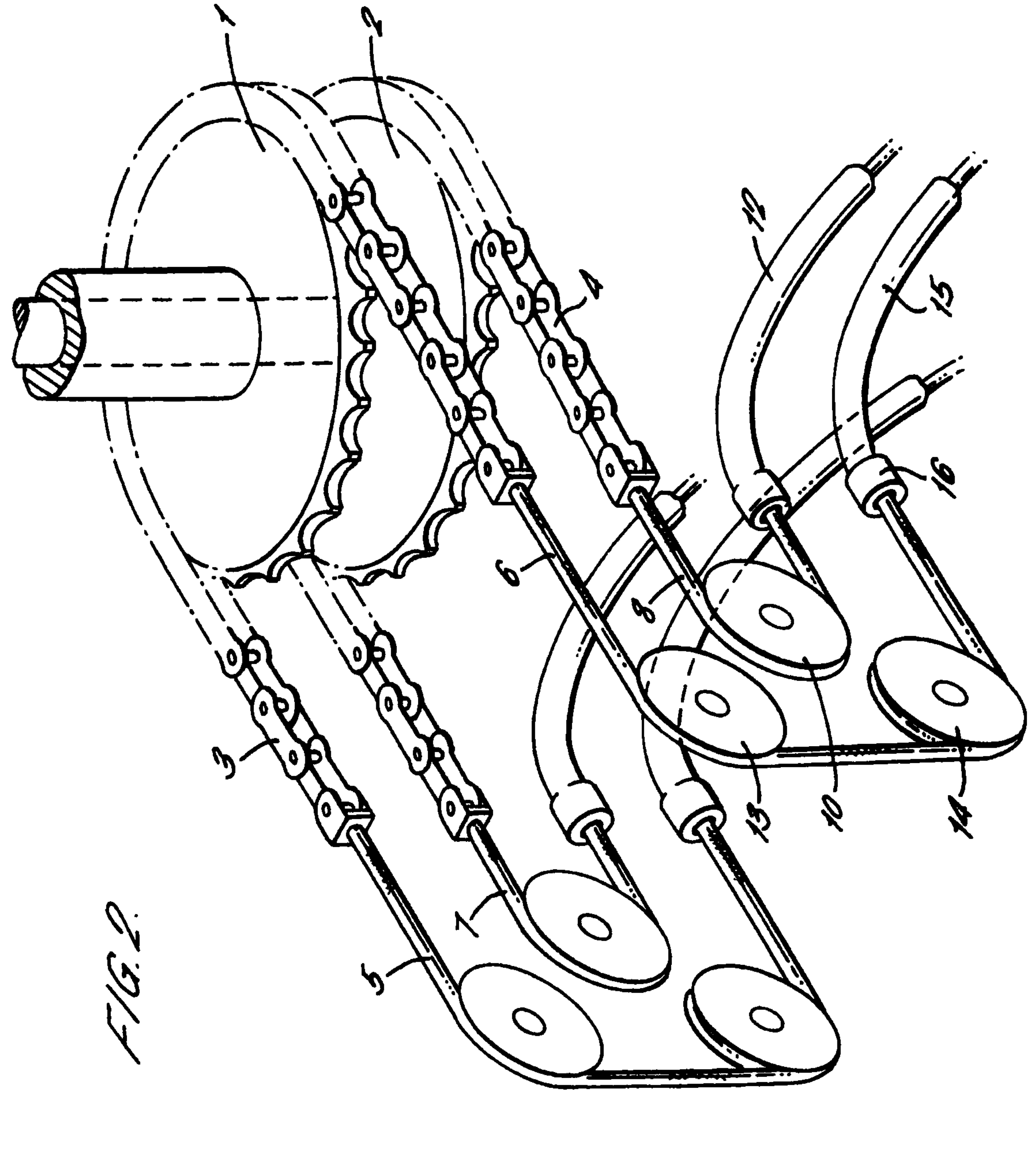


FIG. 2.

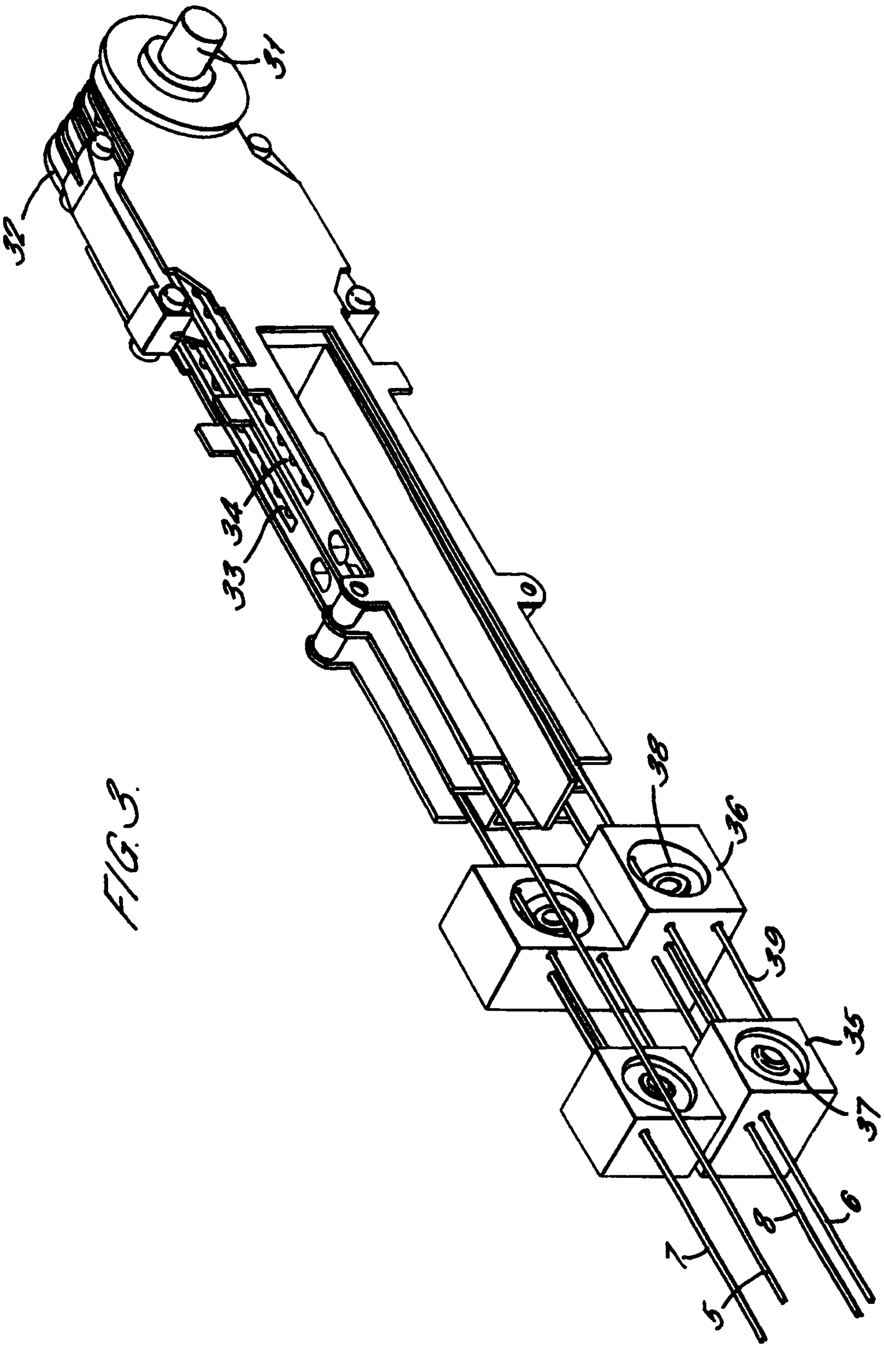
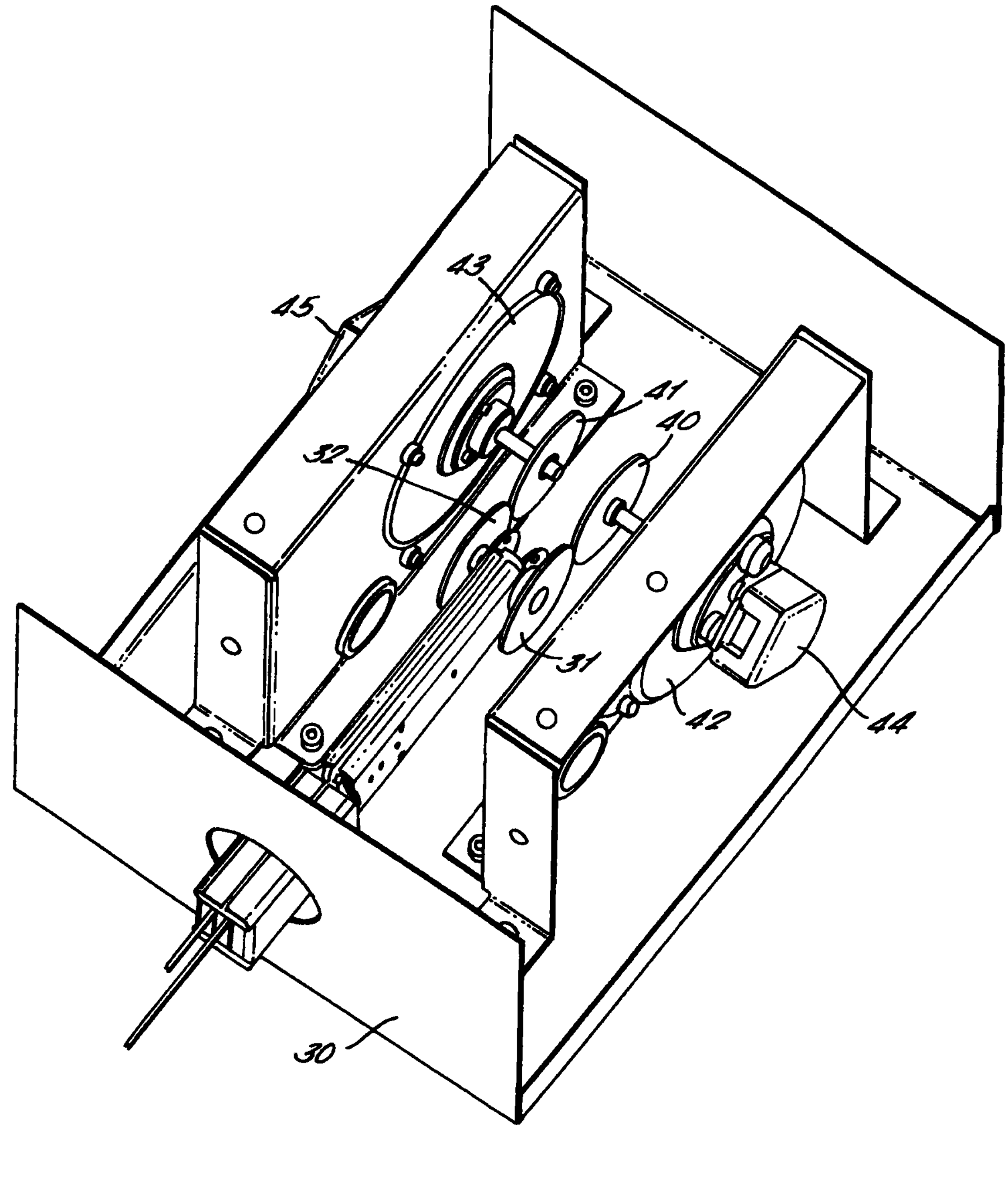


FIG. 3.

FIG. 4.



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A DUMMY MEDICAL INSTRUMENT FOR USE IN A SIMULATOR

The present invention relates to a dummy medical instrument for use in a simulator.

One type of simulator to which the present invention is applicable is that disclosed in GB A 2252656. This simulator simulates the operation of an endoscopic process. A dummy endoscope is insertable into a fixture which is provided with a sensor mechanism to sense the longitudinal and rotational movement of the dummy endoscope. This information is fed to a controller which generates force feedback information based on virtual model data held in the computer memory. The force feedback applied to the dummy endoscope is synchronised with a visual representation of the procedure so as to provide a realistic simulation providing a useful training tool to endoscope users.

With an instrument such as an endoscope, the tip of the endoscope is manipulated by angulation control in the form of one or more control knobs on the handle of the endoscope which are linked to cables which extend down the insertion tube of the endoscope. Turning of the control knobs produces a corresponding movement of the cable and hence the tip. An endoscope can have two control knobs one of which controls the left/right movement of the tip and the other of which controls the up/down movement of the tip.

An example of a dummy medical instrument which uses the angulation cables to transmit the force feedback to the control body is disclosed in our earlier application GB 0213981.4. In this instrument, the

angulator cables are directed along the umbilical of the instrument to the angulation control unit where they are wound around motors which generate a variable force to provide force feedback.

In an operation such as a colonoscopy, the medical practitioner will often twist the control body a number of times to manipulate the endoscope along the colon. In doing this, the umbilical can become severely twisted. In order to remove the coils, the endoscopist or assistant may either reverse the control body at a suitable safe place in the colon, or unplug the umbilical and untwist it. This latter option is not possible with the arrangement disclosed in application number GB 0213981.4 as the four wires extending from the umbilical are permanently wrapped around the force feedback motors. Further, the permanent attachment of the umbilical to the angulation control unit makes transportation and storage of the umbilical difficult.

According to the present invention there is provided a dummy medical instrument for use in a simulator, the instrument comprising a control body with user manipulatable angulation control, an insertion tube and an umbilical extending from the control body, wherein in a real instrument corresponding to the one being simulated, at least one angulation cable would extend from the user manipulatable controls to the tip of the insertion tube such that movement of the angulation control changes the angulation of the tip, and wherein in the dummy medical instrument the angulation cable extends from the user manipulatable angulation control, and down the umbilical, the umbilical having a connector at its distal end allowing it to be releasably attached to an angulation control unit, and means to present the angulation

cable at the distal end, so that, in use, the cable is located in driving engagement with a means in the force feedback unit to apply a variable force to the cable.

By presenting the cable in this way the end of the umbilical and providing a releasable attachment to the angulation control unit, the present invention provides a dummy medical instrument which can be unplugged from the force feedback unit allowing the training endoscopist to remove any tangles in the umbilical as he/she would in performing a real procedure. The invention also allows the instrument to be detached for transportation and storage. Further, the frame can be provided with different instruments for evaluation without the need for separate angulation control units.

Preferably, the dummy instrument is provided with two pairs of angulation cables, each pair forming a continuous loop around the control body, and around a respective pulley at the distal end of the umbilical. Such an arrangement provides the left/right and up/down control provided in a normal endoscope. The cables may have a uniform construction throughout the loop. However, preferably, at the distal end, the cables are formed as chains as these provide a more positive engagement with the pulley.

With use of the instrument, the tension in the cable loops can be reduced. Therefore, preferably, means are provided to vary the tension within the loop. Preferably, this takes the form of a portion of the cable extending into a secondary loop, the size of which can be adjusted in order to vary the tension in the loop.

The present invention also extends to a combination of the dummy medical instrument referred to above together with an angulation control unit, the angulation control unit having means to drivingly engage with the cable and to apply a variable force feed back to the cable.

This driving engagement may take the form of a direct contact between each pulley around which the cables are wound and a respective motor. Contacts may either be a frictional contact, or the pulley and the respective motor may be provided with complementary teeth to provide a more positive engagement. The teeth should be of a relatively fine pitch in order to allow easy engagement between the pulleys and the motor in any relative rotational position.

As an alternative, the mechanical linkage such as a gear or a belt drive may be provided between the pulleys and the motors. This will provide greater freedom to allow the motors to be positioned within the force feed back unit.

The sensors for the at least one angulation cable may be provided in the angulation control unit. However, preferably they are in the dummy medical instrument, as, in this position, they will not lose position if there is slippage between the cable and the means to apply variable force to the cable, or when the dummy instrument is disconnected from the angulation control unit.

An example of a dummy medical instrument constructed in accordance with the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of the angulation system in the control body;

Fig. 2 is a schematic perspective view showing the arrangement of pulleys, cables and angulation control in the control body;

Fig. 3 is a schematic perspective of a connector at the distal end of the umbilical; and

Fig. 4 is a perspective view showing the connector inserted into the angulation feedback controller unit.

The particular medical instrument being described here is an endoscope. However, it may be any medical instrument where cables which are normally manipulated to move a part of the instrument have to be rerouted so that force feedback can be applied to the cable.

The described arrangement is adapted from a conventional endoscope control body. Both of the real and dummy endoscopes have an insertion portion leading from the control body ending at the endoscope tip. In the real instrument, this tip is manipulated to steer it through the colon. An umbilical is provided in both the real and dummy endoscopes leading from the control body to feed various cables to the control body.

The control body is provided with a pair of co-axial rotatable knobs 1,2 as shown in Fig. 2. The outer knob 1, in this case, would, in a normal endoscope, be rotated to move the tip in an up/down direction, while the inner knob 2 would move the tip in a left/right direction orthogonal to the up/down direction. These described directions are only notional directions as, in use, the endoscope may be used in any orientation.

Wrapped around each pulley is a wire chain drive 3,4 to each of which a cable is attached. In the illustrated example there are four cables which, for convenience, are denoted up cable 5, down cable 6, left cable 7 and right cable 8.

In a normal instrument, these cables 5,6,7,8 would extend all the way to the tip of the endoscope to provide the tip movement referred to above upon rotation of the knobs 1,2.

In the dummy instrument, these cables must be rerouted along the umbilical of the instrument which directs them to an angulation control unit. In the angulation control unit, the up/down cables 5,6 are connected to a force feedback motor and the left/right cable 7,8 are connected to a similar motor as described below.

Rotation of the knobs 1,2 is detected and a system controller interprets this information together with information on the longitudinal and rotational positions of the tip of the endoscope. Using data representing a simulated model of a colon, software detects when the simulated tip of the endoscope comes into contact with the simulated colon wall. At this time, the controller sends a force feedback signal to the two feedback motors which hence provides a resistance to the movement of the cables 5-8 which is felt at the knobs 1,2 as a resistance to turning.

In order to route each cable into the umbilical 9, the arrangement shown in Fig. 1 and 2 is employed. Fig. 1 shows the rerouting of two of the cables, namely the down cable 6 and the right cable 8. A similar arrangement is provided on the opposite side of the control body as shown in Fig. 2. However, as this has the same construction and operation as the down/right

configuration shown in Fig. 1, only this configuration is described in detail. The right cable 8 is connected to the chain 4 that surrounds the inner knob 2. This cable then extends around a first pulley 10 rotatably mounted on a housing 11 within the control body. The pulley 10 turns the right cable through 180°. A sheath 12 is connected to the housing 11. The cable 8 enters the sheath 12 at this point and is guided within this sheath into the umbilical which leads it to the feedback motor.

The down cable 6 passes in a loop outside the right cable 8 around a pair of spaced pulleys 13,14 rotatably mounted on the housing 11. The down cable 6 enters a sheath 15 attached to the housing 11 at connector 16 and is also guided into the umbilical to the other force feedback motor as described with reference to the right cable.

To date, the process as described is that disclosed in our earlier application no. 0213981.4

The connection between the angulation control unit and the umbilical which forms the subject of the present invention will now be described with reference to Figs. 3 and 4.

Fig. 3 illustrates the configuration of the cables at the distal end of the umbilical, i.e. the end of the umbilical which connects with the angulation control unit. The cables 5, 6, 7, 8 shown are the opposite ends of the same cables shown in Figs. 1 and 2. The up/down cables 5, 6 form a loop which extends around an up/down pulley 31, while the left/right cables 7,8 form a loop which extends around a left/right pulley 32.

The interface between the cables and the pulleys are similar to the interface shown in Fig. 2. In other words, each of the cables are connected to a chain 33, 34 which engages with teeth (not shown)on the pulleys 31, 32. Thus, rotation of the knobs 1, 2 pulls on the cables 5, 6, 7, 8 hence turning the corresponding pulleys 31, 32.

As shown in Fig. 3, a mechanism for tensioning the cables 5, 6, 7, 8 is shown. The tensioning mechanism takes the form of a pair of blocks 35, 36 in which tensioning pulleys 37, 38 are mounted. These pulleys 37, 38 have similar construction to pulleys 10, 13 and 14 described above. The tensioning device described here is for the up/down cables 5, 6, but it will be appreciated that a second tensioning mechanism is illustrated in Fig. 3 for tensioning the left/right cables 7, 8.

The down cable 6 passes through the block 35 into the block 36 where it is wound around pulley 38. This turns it through substantially 180°, such that it then passes into the block 35 and around pulley 37. Here it is again turned through 180° and passes back through block 36 along to the pulley 31 thereby forming a loop 39. By adjusting the spacing of the blocks 35, 36, the size of the loop can be increased or decreased with a corresponding change in tension in the up/down cable 5, 6. Although shown on the down cable 6, the tensioning mechanism could equally be on the up cable 5.

The insertion of the umbilical into the angulation control unit is shown in Fig. 4. In practice, the pulley system shown in Fig. 3 would be encased in the umbilical housing and a connector body which has a quick release fit with a complementary coupling on the

angulation control unit 30.

As shown in Fig. 4, the end of the umbilical is inserted into the angulation control unit in such a way that the pulleys 31, 32 engage with drive wheels 40, 41, which are driven by angulation motors 42, 43. A keying means on the connector ensures that the pulley system is always inserted in the correct orientation. Optical encoders 44, 45 monitor the movement of the angulation cables. These encoders may alternatively be in the control body or in the connection to the angulation control unit.

Thus, when the simulation software detects that force feedback should be applied to the angulation control, the torque produced by angulation motors 42, 43 is increased. This provides a corresponding increase in resistance transmitted to the pulleys 31, 32 by the drive wheels 40, 41 thereby generating the necessary tactile feel.

If the umbilical becomes twisted, the user can uncouple the quick release coupling connecting the umbilical to the angulation control unit 30, shake out the twists, and recouple the connector, whereupon the pulleys 31, 32 will re-engage the drive wheels 40, 41.

Whilst the umbilical is disengaged, the tip of the endoscope is still inserted within the main force feedback unit (not shown) which will continue to monitor its linear and rotational position.

CLAIMS

1. A dummy instrument for use in a simulator, the instrument comprising a control body with user manipulatable angulation control, an insertion tube and an umbilical extending from the control body, wherein in a real instrument corresponding to the one being simulated, at least one angulation cable would extend from the user manipulatable controls to the tip of the insertion tube such that movement of the angulation control changes the angulation of the tip, and wherein in the dummy medical instrument the angulation cable extends from the user manipulatable angulation control, and down the umbilical, the umbilical having a connector at its distal end allowing it to be releasably attached to a force feedback unit, and means to present the angulation cable at the distal end, so that, in use, the cable is located in driving engagement with a means in the force feedback unit to apply a variable force to the cable.

2. An instrument according to claim 1, wherein the instrument is provided with two pairs of angulation cables each pair forming a continuous loop around the control body, and around a respective pulley at the distal end of the umbilical.

3. An instrument according to claim 2, wherein at the distal end, the cables are formed as chains.

4. An instrument according to claim 3, wherein cable means are provided to vary the tension within the loop.

5. An instrument according to claim 4, wherein the means to vary the tension within the loop are

provided by a portion of the cable extending into a secondary loop, the size of which can be adjusted in order to vary the tension in the loop.

6. A combination of an instrument according to any one of the preceding claim, together with a force feedback unit, the force feedback unit having means to drivingly engage with the cable and to apply a variable force feedback to the cable.

7. A combination according to claim 6 when dependent on claim 2, wherein the driving engagement takes the form of a direct contact between each pulley around which the cables are wound and a respective motor.

8. A combination according to claim 7, wherein the contact is a frictional contact.

9. A combination according to claim 7, wherein the pulley and the respective motor are provided with complementary teeth to provide the direct contact between the pulleys and the cable.

10. A combination according to claim 6, wherein a linkage is provided between each pulley and a respective motor.